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IS 6953 (1973): Code of safety for bromine [CHD 8:
Occupational Safety, Health and Chemical Hazards]



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“Knowledge is such a treasure which cannot be stolen”

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IS : 6953 - 1973

(Reaffirmed 2012)

Indian Standard

CODE OF SAFETY FOR BROMINE

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INDIAN STANDARDS INSTITUTION

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NEW DELHI 110001

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CODE OF SAFETY FOR BROMINE

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Indian Standard

CODE OF SAFETY FOR BROMINE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 11 May 1973, after the draft finalized by the Chemical Hazards Sectional Committee had been approved by the Chemical Division Council.

0.2 Bromine as a liquid or as a vapour is highly irritating to skin, mucous membranes, eyes and respiratory tract. Being a powerful oxidizing agent, it also constitutes a fire hazard.

0.3 For proper utilization of the code of safety for bromine, a knowledge of effects of hazardous substances on biological systems is desirable. This code of safety recommends practices to be followed to ensure safety of personnel engaged in industries where bromine is produced, stored, handled or used.

0.4 In the preparation of this code, assistance has been drawn from 'Chemical Safety Data Sheet No. SD 49 Bromine' issued by the Manufacturing Chemists Association, Washington, D.C., USA.

1. SCOPE

1.1 This standard describes properties of bromine, the nature of hazards associated with it and essential information on storage, handling, packing, labelling, disposal of waste, cleaning and repair of containers, selection and training of personnel, protective equipment and first-aid.

1.1.1 This code does not deal with specification for design of buildings, chemical engineering plants, storage vessels, equipment for operations control and waste disposal.

2. TERMINOLOGY

2.1 For the purpose of this code, the definitions given in IS:4155-1966* and IS : 4167-1966† shall apply.

*Glossary of terms relating to chemical and radiation hazards.

†Glossary of terms relating to air pollution.

3. IMPORTANT PHYSICAL AND CHEMICAL PROPERTIES

3.1 Important physical and chemical properties of bromine are given below:

a) Colour of liquid/vapours	Heavy reddish-brown
b) Boiling point	59°C. Bromine is liquid at ordinary temperature
c) Freezing point	-7.3°C
d) Vapour density	5.5 at 15°C
e) Vapour pressure	175 mm Hg at 20°C
f) Density	3.12 at 20°C and 2.928 at 59°C
g) Solubility	Soluble in alcohol, ether, chloroform and carbon disulphide, slightly soluble in water
h) Odour	Sharp, penetrating odour
j) Reactivity	Anhydrous bromine is less reactive than wet bromine with many of the elements and metals. It is a powerful oxidizing agent particularly in presence of water. It reacts vigorously with reducing agents and with many organic compounds, such as phenols, amines, hydrocarbons, ketones, acids of aliphatic and aromatic series

4. HAZARDS ASSOCIATED WITH BROMINE

4.1 **Health Hazards** — Either as a liquid or as a vapour, bromine acts as a local irritant and corrosive on contact with body tissues. Vapours are irritating to eyes, skin and respiratory tract. The threshold limit value (TLV*) for bromine in air is 0.1 ppm (0.7 mg/m³) for 7 to 8 hours work day and 40 hours work week.

4.1.1 *Acute Toxicity*

4.1.1.1 *Local effects* — Liquid bromine produces a mild cooling sensation on first contact with the skin. This is followed by sensation of heat. If bromine is not removed immediately the skin becomes red and finally brown. Such a contact will result in destruction of the skin area involved and development of an indolent, slow healing ulcer.

*As accepted by American Conference of Governmental Industrial Hygienists, Ohio, USA.

Bromine is especially hazardous to the tissues of the eyes, severely painful and destructive burns may result from contact with either liquid or concentrated vapour.

4.1.1.2 Systemic effects—Bromine has excellent warning properties and systemic intoxication is unlikely. Lachrymation is caused by concentrations less than 1 ppm, while 10 ppm concentration would cause extreme upper respiratory irritation which will not be voluntarily borne. Concentrations of 40-60 ppm are dangerous to life on exposure for 0.5 to 1 hour, those of 500-1 000 ppm are rapidly fatal to short exposure. If bromine vapours are present in a confined space, severe respiratory tract injury may result followed by pulmonary edema, pneumonia and respiratory failure.

4.1.2 Chronic Toxicity—Because of the extremely irritating nature and intolerability to body tissues, chronic systemic poisoning or local effects are unlikely.

4.2 Fire Hazards—Bromine itself will not burn but it is a strong oxidizer. Dry bromine will react violently with the metals—aluminium, titanium, mercury and potassium. Due to its high reactivity with many other substances, the heat of reaction may raise the temperatures to the ignition points of combustible materials. Neutralization of bromine with an alkali will produce bromates which when dry may be hazardous from a fire and explosion standpoint.

5. STORAGE

5.1 Bromine is usually stored in lead lined containers and nickel drums or in glass bottles. Earthenware, stoneware and Monel metal containers may also be used for storage of bromine.

5.1.1 For authorized containers, an outage (vacant space over liquid) of not less than 10 percent of the capacity of the container is required.

5.2 Bromine should be stored in a cool well ventilated area avoiding direct sunlight. The temperature of storage area should not go below —7°C to prevent freezing.

5.3 Bromine should be stored away from other chemicals and organic chemicals.

5.4 Bromine vapours from reaction vessels or storage tanks should be vented through an alkali absorber preferably kept under constant pressure. The vent line should be purged with dry air.

5.5 Electrical fittings in area where bromine vapours are likely to be present should be able to withstand the corrosive effect and should be of vapour proof construction, wiring being in tight, rigid metal conduits.

5.6 Glass or porcelain piping, free from stresses or strains, is highly satisfactory with polytetrafluoroethylene (PTFE) and asbestos sheathed gaskets on flange joints.

6. HANDLING

6.1 General—The general handling practices given in 6.1.1 to 6.1.7 should be followed.

6.1.1 All handlers should be aware of the potential hazards of bromine and of appropriate first-aid measures.

6.1.2 Exhaust hoods and ventilation should be adequate to maintain the concentration of bromine vapour in the work area below 0.1 ppm. Air analyses will be necessary for proper control.

6.1.3 Safety showers and eye-wash fountains should be immediately at hand where contact is at all likely.

6.1.4 If there is significant risk of exposure an operator should not handle bromine without available assistance in the area.

6.1.5 Bromine, in any breakable package or line, should be kept at as low a level as possible above protection pans.

6.1.6 Storage and operations should be over drip pans draining to a sump.

6.1.7 Sumps should be sufficiently large to prevent general contamination in case of spills and shall be ventilated to prevent escape of vapours into inhabited areas.

6.2 Spills and Leakage

6.2.1 In the case of bromine spillage, ammonia gas vapours should be released to the area from a safe distance.

CAUTION: Only anhydrous ammonia gas should be used for vapour decontamination. Violent reaction may follow the mixing of aqueous ammonia and liquid bromine.

6.2.2 Hypo solution, lime water slurry, or soda ash solution may be poured over a liquid bromine spill on the floor. The bromine and neutralizer should be washed to the sump or sewer with a cold water hose. (Hypo solution is prepared by dissolving 220 g of technical sodium thiosulphate in a litre of water and adding 100 g of soda ash. The solution will remain stable for four to six weeks.)

6.2.3 Until decontamination is complete, a mild ammonia atmosphere should be maintained. Doors and windows may be opened to remove the white clouds of ammonium bromide formed.

6.3 Glass Bottles—Hermetically-sealed glass containers should be first cooled and then opened with extreme caution.

6.3.1 The lead cap should be loosened cautiously and taken off the bottle. Mechanical means of siphoning instead of mouth suction should be used to siphon bromine from the bottle.

6.4 Drums—Drums and containers should be inspected for loose plugs, signs of leakages, or damage.

6.4.1 Drums or containers should not be dropped.

6.4.2 Application of pressure for emptying the drums should not be attempted.

7. PREVENTIVE MEASURES

7.1 Good ventilation should be maintained at all times in all locations where bromine is stored or handled. Local exhaust ventilation may at times be required where higher concentrations may occur. At all times ventilation should be sufficient to keep exposure at or below the threshold limit of one-tenth (0.1) ppm, which is considered safe for repeated eight hour exposures.

7.2 Personal Hygiene—Workers should be thoroughly instructed and supervised in proper operating procedures to avoid exposure to bromine liquid or vapours. Where exposure is possible, personal protective equipment should be used.

7.2.1 All contaminated clothing, including gloves, shoes, overalls, etc, should be removed immediately to avoid prolonged contact with bromine and should be thoroughly decontaminated and cleaned before re-use.

7.2.2 Working areas, storage rooms and unloading areas should be well equipped with safety showers, readily accessible and plainly marked. Eye washing fountains or running tap water, such as a bubbler drinking fountain or a hose should be available for eye irrigation. The location of such equipment should be inspected and tested at fixed intervals to make sure that it is in good working condition at all times.

7.3 Physical Examinations—Diseases of the heart or lungs should exclude an employee from working with bromine.

7.4 Personal Protective Equipment

7.4.1 Availability and Use—While personal protective equipment is not an adequate substitute for safe working conditions, adequate ventilation and intelligent conduct on the part of employees working with bromine, it is in many instances, the only practical means of protecting the worker, particularly in emergency situations. One should keep firmly in mind that personal protective equipment protects only the worker wearing it, and other unprotected workers in the area may be exposed to danger.

7.4.2 Eye Protection — The following personal protective equipment should be used when indicated:

- a) *Chemical safety goggles* — Cup type or rubber framed goggles equipped with approved impact glass or plastic lenses should be worn, whenever there is danger of bromine coming in contact with the eyes. Goggles should be carefully fitted.
- b) *Face shields* — Plastic shields (full length, 20 cm minimum) with forehead protection may be worn in addition to chemical safety goggles where complete face protection is desirable. Chemical safety goggles should always be worn as added protection where there is danger of bromine striking the eyes from underneath or around the sides of the face shield.
- c) *Spectacle-type safety goggles* — Metal or plastic rim safety spectacles with side shields which can be obtained with prescription safety lenses or suitable all-plastic safety goggles may be used where continuous eye protection is desirable, *These types, however, should not be used where complete eye protection against bromine is needed.*

7.4.3 Respiratory Protection — Severe exposure to bromine may occur in tanks during equipment cleaning and repairs, when decontaminating areas following spills, or in case of failure of piping or equipment. Employees who may be subject to such exposure should be provided with proper respiratory protection and trained in its use and care. Available types are described in 7.4.3.1 to 7.4.3.5.

NOTE — Respiratory protective equipment shall be carefully maintained, inspected, cleaned and sterilized at regular intervals, and always before and after use by another person.

7.4.3.1 Self-contained breathing apparatus — Permitting the wearer to carry a supply of oxygen or air compressed in the cylinder and the self-generating type which produces oxygen chemically. These allow considerable mobility. The length of time a self-contained breathing apparatus provided protection varies according to the amount of air, oxygen or regenerating material carried. Compressed oxygen should not be used where there is danger of contact with flammable liquids, vapours, or sources of ignition, especially in confined spaces, such as tanks or pits.

7.4.3.2 Positive pressure hose masks — The air shall be supplied by blowers requiring no internal lubrication. The wearer shall be able to use the same route for exit as for entrance and shall take precautions to keep the hose line free of entanglement. The air blower shall be placed in an area free of contaminants.

7.4.3.3 Air-line masks — Supplied with clean compressed air. These are suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply. These masks are usually supplied

with air piped to the area from a compressor. It is extremely important that the air supply is taken from a safe source and that it is not contaminated by oil decomposition from inadequate cooling at the compressor. The safer method is to use a separate compressor of the type not requiring internal lubrication. Pressure reducing and relief valves as well as suitable traps and filters must be installed at all mask stations. An alternative arrangement frequently used is high pressure breathing air from cylinders, with demand-type valve and face piece.

7.4.3.4 Industrial canister type gas masks — Equipped with full face pieces fitted with the proper canister for absorbing bromine vapour. These will afford protection against concentrations not exceeding 1 percent by volume when used in accordance with manufacturer's instructions. The oxygen content of the air must not be less than 16 percent by volume. The masks should be used for relatively short periods only. They may not be suitable for use in an emergency since, at that time, the actual vapour concentration is unknown and also an oxygen deficiency may exist. The wearer must be warned to leave the contaminated area immediately on detecting the odour of a harmful vapour. This may indicate that the mask is not functioning properly, that the vapour concentration is too high, that the canister is exhausted or that the mask is not properly fitted.

7.4.3.5 Chemical cartridge respirators — May be used to avoid inhaling disagreeable concentrations of bromine vapour. These respirators, however, are not recommended for protection where toxic quantities may be encountered.

7.4.4 Head Protection — 'Hard' hats should be worn where there is danger from falling objects. If hard hats are not considered necessary, soft-brimmed hats or caps may be worn to give protection against overhead leaks.

7.4.5 Foot Protection — Leather or rubber safety shoes with built-in steel toe caps are recommended. Rubbers may be worn over leather safety shoes. Leather shoes should be discarded after any contact with bromine.

7.4.6 Body, Skin and Hand Protection

- a) Suits made of rubber or suitable protective material and properly designed, should be used wherever complete body protection is necessary.
- b) Aprons made of rubber or other suitable protective material should be used for protection against accidental contact.
- c) Gloves made of rubber or other suitable protective material should be worn to protect the hands from bromine.

- d) Sleeves made of suitable protective materials should be worn when the need for complete arm protection is indicated.
- e) When cleaning, inspecting, or repairing tanks, safety equipment, such as safety belts, rescue harness, life-line, protective clothing and gas masks should be worn as required by the specific nature of the work and the hazards involved.
- f) Frequent inspections and necessary repairs should be made of all personal protective equipment so that the wearer will be adequately protected. Rubber and other impervious apparel must be checked frequently for signs of deterioration due to exposure to bromine.
- g) All contaminated clothing, including gloves, shoes, coveralls, etc, should be removed as soon as possible after exposure to avoid prolonged contact with bromine. It should be thoroughly decontaminated and cleaned before re-use.

8. LABELLING

8.1 Every container should carry the illustrations of 'powerful oxidizing agent' and 'corrosive' symbols as depicted in Fig. 9 and Fig. 15 of IS : 1260 (Part I)-1973*.

8.2 The container shall carry the following label:

'May ignite a combustible material upon contact. Causes severe burns to eyes and skin. Vapours are hazardous. Do not inhale them. Use with proper ventilation. In case of contact flush with water immediately and get first-aid. If eyes are involved, consult a medical specialist'.

This label may be used with any other illustration/descriptions.

9. FIRST-AID

9.1 If bromine is accidentally spilled on skin, the area should be promptly washed, if necessary, under safety shower and a paste of sodium bicarbonate may be applied to the affected area.

9.2 In case of contact with eyes, they should be irrigated for at least fifteen minutes with clean running water.

9.3 In case of inhalation, the person should be removed from the toxic atmosphere promptly to open air and all constricting cloth about neck should be loosened. The patient should be kept warm and oxygen administered.

9.4 A medical specialist should be summoned at once in all cases.

*Pictorial markings for handling and labelling of goods: Part I dangerous goods (first revision).

10. TANK CLEANING AND REPAIRS

10.1 The hazardous nature of tank inspection, cleaning or repairs requires that the foreman and crew be selected and trained carefully. They should be thoroughly familiar with the hazards, and safeguards necessary for the safe performance of the work. Written approval should be secured from the plant supervisor before the work is started. All tank work should be done under direct supervision.

10.2 Pipelines into or out of the tank or other equipment should be shut off, disconnected, and a blank flange should be installed for protection against leaks and errors. Valves and cocks in the pipe line should not be relied upon.

10.3 Lock electrical switches in the off position, remove drive belts, and otherwise completely safeguard against accidentally starting the agitating equipment or other moving parts located inside the tank or adjacent to the entrance.

10.4 Before entering a tank and during the work, tests should be made by a qualified person to determine that no further washing is necessary, that no oxygen deficiency exists, and that no harmful gas or vapour is present. The tank should be purged continuously with an air stream during all work within the tank.

10.5 Proper personal protective equipment should be worn by anyone entering a tank for inspection, cleaning, or repairs.

10.6 One man on the outside of the tank should keep the men in the tank under constant observation and at least two other men should be available to aid in the rescue, if any, of those in the tank are overcome.

10.7 A hose mask, an airline mask or self-contained breathing apparatus together with rescue harness and life line should be located outside the tank entrance.

10.8 The portable electric lights and power tools should be of the three wire, grounded type.

10.9 Additional precautions are recommended as follows:

- a) Drain tank as completely as possible,
- b) Wash thoroughly with large quantities of water, and
- c) Dry completely tank by blowing with warm dry air.

11. WASTE DISPOSAL

11.1 Make sure all Central, State and Local regulations regarding health and pollution of air and water are followed.

11.2 Dilute and neutralize before disposal as indicated in **11.2.1** to **11.2.3**.

11.2.1 In the case of bromine spillage, ammonia gas vapours should be released to the area from a safe distance.

CAUTION : Only anhydrous ammonia gas to be used for vapour decontamination. Violent reaction may follow the mixing of aqueous ammonia and liquid bromine.

11.2.2 Hypo solution and a lime and water slurry or soda ash solution may be poured over a liquid bromine spill on the floor. The bromine and neutralizer should be washed to the sump or sewer with a cold water hose.

11.2.3 Until decontamination is complete a mild ammonia atmosphere should be maintained. Doors and windows may be opened to remove the white clouds of ammonium bromide formed.

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ON
CHEMICAL AND ALLIED HAZARDS

IS:

- 1260-1973 Code of symbols for labelling of dangerous goods
- 1446-1959 Classification of dangerous goods
- 1913-1961 General and safety requirements for electric light fittings
- 2551-1963 Danger notice plates
- 2553-1964 Safety glass (*revised*)
- 2925-1964 Industrial safety helmets
- 4155-1966 Glossary of terms relating to chemical and radiation hazards
- 4209-1966 Code of safety for chemical laboratories
- 4262-1967 Code of safety for sulphuric acid
- 4263-1967 Code of safety for chlorine
- 4264-1967 Code of safety for caustic soda
- 4312-1967 Code of safety for lead and its compounds
- 4544-1968 Code of safety for ammonia
- 4560-1968 Code of safety for nitric acid
- 4607-1968 Classification of hazardous chemicals and chemical products
- 4644-1968 Code of safety for benzene, toluene and xylene
- 4906-1968 Code of safety for radiochemical laboratory
- 5184-1969 Code of safety for hydrofluoric acid
- 5208-1969 Code of safety for acetic acid
- 5302-1969 Code of safety for acetic anhydride
- 5311-1969 Code of safety for carbon tetrachloride
- 5685-1970 Code of safety for carbon disulphide (carbon bisulphide)
- 6156-1971 Code of safety for chlorosulphonic acid
- 6164-1971 Code of safety for hydrochloric acid
- 6269-1971 Code of safety for ethylene oxide
- 6270-1971 Code of safety for phenol

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534 Sardar Vallabhbhai Patel Road, BOMBAY 400007	35 69 44
5 Chowringhee Approach, CALCUTTA 700013	23-08 02
5-9-201/2-A (First Floor), Chirag Ali Lane, HYDERABAD 500001	3 44 35
117/418 B Sarvodaya Nagar, KANPUR 208005	82 72
54 General Patters Road, MADRAS 600002	8 72 78